

820012 - CIA - Industrial Control and Automation

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering

Teaching unit: 707 - ESAII - Department of Automatic Control

Academic year: 2017

Degree: BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)

ECTS credits: 6 Teaching languages: Catalan, Spanish

Teaching staff

Coordinator: JOAN DOMINGO PEÑA

Others: JOAN SEGURA
JORDI SOLA
ANTONIO CALOMARDE
MARIA MAQUEDA
LEONARDO SARLABOUS
ALEX VALLMITJANA

Opening hours

Timetable: Previous hours to the class in teacher desk and preferably by appointment by e-mail.

Prior skills

For good follow the subject, is recommended to have passed the following subjects:

- Mathematics (I and II)
- Physics
- Electrical Systems
- Mechanical systems
- Computer Basics

Degree competences to which the subject contributes

Specific:

CEI-12. Understand the fundamentals of automatic control methods.

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Transversal:

1. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.
2. EFFECTIVE USE OF INFORMATION RESOURCES - Level 2. Designing and executing a good strategy for advanced searches using specialized information resources, once the various parts of an academic document have been identified and bibliographical references provided. Choosing suitable information based on its relevance and quality.

Teaching methodology

The course uses approximately methodology expositive/participative by 25%, the 50% is individual work, and group work by 25%. We also used the techniques of cooperative learning and project/problem-based learning. The practical realization is essential to better understand the concepts worked.

Learning objectives of the subject

1. Acquire basic skills in design, analysis and implementation of automated systems.
2. Knowing different devices, components and systems involved in the process automation industry.
3. Making an industrial automation PLC based.
4. Learn the fundamentals of dynamic systems.
5. Understand methods of control systems.
6. Teamwork.
7. Management of information resources in the field of automation of industrial processes.

Study load

Total learning time: 150h	Hours large group:	45h	30.00%
	Hours medium group:	0h	0.00%
	Hours small group:	15h	10.00%
	Guided activities:	0h	0.00%
	Self study:	90h	60.00%

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Content

<p>- Unit 1_1</p>	<p>Learning time: 9h Theory classes: 2h 30m Laboratory classes: 1h Guided activities: 0h 30m Self study : 5h</p>
<p>Description: Introduction to industrial automation. Control and regulation. Type of automation. Law of command. Part of command and operational part. Basic architecture of control systems in open loop and closed loop.</p> <p>Related activities: Read complete guide (without annexes) Reading the information in Annex 1 Reflection synthesis Reading the text of Annex 2 Assignment 1: Self evaluation Assignment 2: Write a definition of control law Reading the text of Annex 3 Assignment 3: Make a list of advantages and disadvantages of industrial control and self-matització Fill the template of time spent Send files to Virtual Campus Lab practices Classroom problems/exercicies Homework problems/exercicies</p> <p>Specific objectives: Upon completion of the activities students will be able to:</p> <ul style="list-style-type: none"> - Understand the scope and content of the course and details relating to staff, dedication weekly regimen of practices, evaluation system and bibliography. - Make a definition of Control Law using quality criteria. - Differentiate the control to open loop and closed loop. - Be aware of the scope and usefulness of industrial automation and its consequences. - To apply automation technologies. 	

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<p>- Unit 1_2</p>	<p>Learning time: 9h Theory classes: 2h 30m Laboratory classes: 1h Guided activities: 0h 30m Self study : 5h</p>
<p>Description: Sensors; classification, characteristics, and connection type.</p> <p>Related activities: Reading the text of Annex 1 Reflection synthesis Assignment 1: Finding information Assignment 2: Finding information Assignment 3: Finding information Assignment 4: Work on sensors and actuators Fill in file time Shipping to Virtual Campus Practice lab Problem/exercicies sessions Homework problem/exercices</p> <p>Specific objectives: Upon completion of the activities the student will be able to: - Differentiate sensor transducer. - Learn the most common sensors and ways of wiring.</p>	

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<p>- Unit 1_3</p>	<p>Learning time: 9h Theory classes: 2h 30m Laboratory classes: 1h Guided activities: 0h 30m Self study : 5h</p>
<p>Description: GRAF CET: elements and structures. Schematic with ladder. Deploying wired and programmable automation. Examples.</p> <p>Related activities: Reading the text of Annex 1 Reflection synthesis Assignment 1: Finding information Assignment 2: solving exercise Fill in file time Shipping to Virtual Campus Practice lab Problem sessions Homework problems</p> <p>Specific objectives: Upon completion of the activities the student will be able to: - Being able to explain what a GRAF CET. - Know the most common structures GRAF CET.</p>	

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<p>- Unit 1_4</p>	<p>Learning time: 10h Theory classes: 2h 30m Laboratory classes: 1h Guided activities: 0h 30m Self study : 6h</p>
<p>Description: Actuator's: types and connection. Electric, pneumatic and hydraulic. Electrovalves.</p> <p>Related activities: Access to information Reading the text of Annex 1 Reflection synthesis Assignment 1: resolution of exercise Fill in file time Shipping to Virtual Campus Practice lab Problem sessions Homework problems</p> <p>Specific objectives: At the end of the activities the student will be able to: - Differentiate the different types of actuators. - The autoenclavaments relays as memory circuits. - Be able to make schematic connection of actuators and pre-actuators.</p>	



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<p>- Unit 2_1</p>	<p>Learning time: 12h Theory classes: 3h Laboratory classes: 1h Guided activities: 6h Self study : 2h</p>
<p>Description: Introduction to PLC.</p> <p>Related activities: Access to information Reading the text of Annex 1 and web Reflection synthesis Assignment 1: resolution of issues Fill in file time Shipping to Virtual Campus Practice lab Problem sessions Homework problems</p> <p>Specific objectives: Upon completion of the activities the student will be able to:</p> <ul style="list-style-type: none">- Understand PLC types.- Write a PLC program.- Identify the elements of the programming language of PLCs.- Learn what are the languages of IEC 61131.	

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<p>- Unit 2_2</p>	<p>Learning time: 9h Theory classes: 2h 30m Laboratory classes: 1h Guided activities: 0h 30m Self study : 5h</p>
<p>Description: PLC: Architecture. Scan Cycle. Configurations. Memory Structure. Software elements.</p> <p>Related activities: Reading Annex 1 Assignment 1: Questionnaire Reading Annex 2 Assignment 2: Questionnaire Reading Annex 3 Assignment 3: Exercise Shipping to Virtual Campus Practice lab Problem sessions Homework problems</p> <p>Specific objectives: Upon completion of the activities the student will be able to:</p> <ul style="list-style-type: none"> - Explain what is a PLC and its use in automation systems. - Understand the internal architecture of a PLC. - Explain characteristics of this technology in relation to technology - Be able to write simple PLC programs wired. - Explain what is a PLC scan cycle. - Explain how is structured the PLC memory and his addressing systems. 	

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<p>- Unit 2_3</p>	<p>Learning time: 10h Theory classes: 2h 30m Laboratory classes: 1h Guided activities: 0h 30m Self study : 6h</p>
<p>Description: PLC Programming: combinational elements and sequences with scales, timers, counters and others. Analog part of PLC and connection to and from analog components. Control of induction motors with inverters; connection and programatic. Examples.</p> <p>Related activities: Reading the text of Annex 1 Reflection synthesis Assignment 1: resolution of issues Fill in file time Shipping to Virtual Campus Practice lab Problem sessions Homework problems</p> <p>Specific objectives: Upon completion of the activities the student will be able to:</p> <ul style="list-style-type: none"> - Programming a PLC using lists of instructions and diagrams contacts. - Use the resources of programming a PLC. - Explain how the map is distributed memory of the PLC. - Connect sensors and actuators, digital and analog, to PLC. - Use timers and counters a PLC. - Know, connect and program inverters for control of induction motors. 	

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<p>- Unit 3_1</p>	<p>Learning time: 10h Theory classes: 2h 30m Laboratory classes: 1h Guided activities: 0h 30m Self study : 6h</p>
<p>Description: Difference between automation and control. Continuous systems. Analog signal. Modelling. Transformations temporal frequency domain. Basic criterion of stability. Order systems 0, 1 and 2. Higher order systems. Time response of continuous systems.</p> <p>Related activities: Reading the text of Annex 1 Reflection synthesis Assignment 1: resolution of issues Reading the text of Annex 2 Fill in file time Shipping to Virtual Campus Reading the example of Annex 3 Practice lab Problem sessions Homework problems</p> <p>Specific objectives: At the end of the activities the student will be able to:</p> <ul style="list-style-type: none"> - Differentiate automation and control - Be able to explain what they are and how they respond systems order 0, 1 and 2 - Recognize whether a system is stable or not - Identify the behavior of a system and the type of response from the canonical functions - Establish the equivalent mathematical model of simple physical system 	

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<p>- Unit 3_2</p>	<p>Learning time: 33h Theory classes: 7h 30m Laboratory classes: 3h Guided activities: 1h 30m Self study : 21h</p>
<p>Description: 3.2 .- Transfer functions. Block diagrams. Simulation and simulators. Stability: poles and zeros and consequences of their position in the Real-Imaginary plane. Root locus (Evans graph), stability criteria of Routh-Hurwitz and Nyquist. Compensation of poles and zeros. Cases and examples.</p> <p>Related activities: Training groups Identification systems, simulators, classroom Solving exercises related to transfer functions and block diagrams Solving exercises related to stability Applying the Routh criteria Using graphics of roots locus and Nyquist</p> <p>Specific objectives: Upon completion of the activities the student will be able to:</p> <ul style="list-style-type: none"> - Make transfer functions from differential equations. - Build and simplify block diagrams. - Use a simulator as help of characterization of systems - To determine the stability of a system in open and closed loop - Compensate poles and zeros. - Use root locus and Nyquist graphics. 	

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<p>- Units 3_3 & 3_4</p>	<p>Learning time: 10h Theory classes: 2h 30m Laboratory classes: 1h Guided activities: 0h 30m Self study : 6h</p>
<p>Description: Open and closed loop. Continuous regulators. Actions P, I, D, PI, PD, PID. Effect of each action on a system. PID syntonization criteria, Ziegler-Nichols and variants.</p> <p>Related activities:</p> <ul style="list-style-type: none">- Reading and study of teaching materials- Practices- Exercises solved in class- Exercises to be solved in class, team- Homeworks- Use of simulators <p>Specific objectives:</p> <p>At the end of the activities the student will be able to:</p> <ul style="list-style-type: none">- Recognize the effect of P, I and D actions and their combined- Tune regulator- Discussion of the stability of open and closed loop systems- Wear simulators- Perform practically a PID control of a second order system with a PLC as a regulator	

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<p>- Unit 4 (Project)</p>	<p>Learning time: 9h Theory classes: 2h 30m Laboratory classes: 1h Guided activities: 0h 30m Self study : 5h</p>
<p>Description: Presentation of a project. The Gantt chart. Group work. The project documentation. Working methodologies. Make a project of automation and control with PLC. Simulation results, budgeting and calculating energy consumption.</p> <p>Related activities: Complete reading of this guide (without annexes) Elaboration of a Gantt chart Rules teamwork Attainment Targets Completion of a technical report sections Process simulation both analog and digital Sending Athena</p> <p>Specific objectives: At the end of the activities the student will be able to:</p> <ul style="list-style-type: none"> - Do a full automation project. - Make Gantt charts. - Make memories projects. - Teamwork. - Searching for information according to a rubric. 	

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<p>- Unit 5</p>	<p>Learning time: 2h Theory classes: 1h Self study : 1h</p>
<p>Description: Introduction to data acquisition systems, supervision and control. Basic Elements. Distribution of basic elements and communication between them. The graphical interface with the latest features and typical components. Data acquisition and control variables: characteristics and configuration. Introduction to industrial communications.</p> <p>Related activities: Complete reading of study guide Read Chapter 1 Systems Supervisión CEA-IFAC (CEA-IFAC_Cuadernos_Supervisión_1.pdf file) Taking a Reading Annex 1 Taking 2 Reading Annex 2 Taking 3 Reading Annex 3 4 Commissioning Fill the template of time spent Shipping to Virtual Campus Problem sessions Homework problems</p> <p>Specific objectives: Upon completion of the activities the student will be able to:</p> <ul style="list-style-type: none"> - Explain what we mean by data acquisition system, supervision and control and what are its basic elements. - Recognize the responsibility of a monitoring system and control the operation of the plant controlled. - Explain the basic capabilities offered by commercial software monitoring and control its use. 	

Qualification system

- Partial controls: 40% (two, with 20% each). These controls are personal, written and performed in classroom.
- Control of practices: 10%
- Exercises and problems: 15% whenever it made and delivered 80% of proposed during the course (IF [n°probl <> 0] > 80% Average THEN 0 ELSE)
- Lab practices: 10% whenever it made and delivered 80% of proposed during the course (IF [n°probl <> 0] > 80% Average THEN 0 ELSE)
- Competence Management information resources 10%. This competence and participation in debates usually take place via Twitter.
- One comprehensive project with the contents of the subject at the end of the course. Add just a 15% of the final grade. This subject not has re-evaluation because is based on a continuous assessment system where every student must be adding qualifications throughout the whole course, many of them derived from such teamwork in the classroom and outside the classroom.

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Regulations for carrying out activities

No further delivery to the campus or in hand when this is proposed, which is made entirely by computer and office tools, and PDF format file. Only be given exercises hand written when carried out in the same class session. Which are outside of class, will always be machine made and PDF. Also supplies paper exercises.

Practices are hand delivered solved unless otherwise indicated.

Regarding partial control is recommended to have a calculator and has completely banned the use of mobile phones. If necessary, the teacher will warn before the test. Unless specified otherwise all controls can be made with classnotes, books, computers, tablets, etc.

Bibliography

Basic:

Balcells Sendra, Josep; Romeral Martínez, José Luís. *Autómatas programables*. Barcelona: Marcombo, 1997. ISBN 84-2671-089-1.

Kuo, Benjamin C.. *Sistemas Control Automático*. 7a ed. México: Prentice Hall, 1996. ISBN 968-880-723-0.

Dorf, Richard C. *Sistemas de control moderno*. 10a ed. Madrid [etc.]: Prentice Hall, cop. 2005. ISBN 8420544019.

Ogata, Katsuhiko. *Ingeniería de control moderna*. 3ª ed. México D.F. [etc.]: Prentice-Hall Hispanoamericana, 1998. ISBN 9701700481.

Lewis, Paul H.; Yang, Chang. *Sistemas de control en ingeniería*. Madrid [etc.]: Prentice Hall, 1999. ISBN 84-8322-124-1.

Goodwin, Graham C; Graebe, Stefan F; Salgado, Mario E. *Control system design*. Upper Saddle River, N.J.: Prentice-Hall, 2001. ISBN 0139586539.

Complementary:

Mandado Pérez, Enrique [et al.]. *Autómatas programables : entorno y aplicaciones*. Madrid: International Thomson Paraninfo, cop. 2005. ISBN 84-9732-328-9.

Bryan, L. A; Bryan, E.A. *Programmable controllers : theory and implementation*. 2nd ed. Atlanta: Industrial Text, cop. 1997. ISBN 094410732X.

Others resources:

Study Guides for each unit or topic of the course related to the theory, practices and exercises.

Computer material

Notes and materials for the course